VATT Working Papers 93

The effects of tax-deductible reserves on investment incentives

Seppo Kari

VATT INSTITUTE FOR ECONOMIC RESEARCH

VATT WORKING PAPERS

93

The effects of tax-deductible reserves on investment incentives

Seppo Kari

Valtion taloudellinen tutkimuskeskus
VATT Institute for Economic Research
Helsinki 2017

Seppo Kari, VATT Institute for Economic Research, seppo.kari@vatt.fi

The author thanks Olli Ropponen for helpful comments.

ISBN 978-952-274-200-1 (PDF)

ISSN 1798-0291 (PDF)

Valtion taloudellinen tutkimuskeskus
VATT Institute for Economic Research
Arkadiankatu 7, 00100 Helsinki, Finland

Helsinki, August 2017

The effects of tax-deductible reserves on investment incentives

VATT Institute for Economic Research
VATT Working Papers 93/2017

Seppo Kari

Abstract

This paper investigates how tax-deductible reserves affect the incentive to invest. We consider two different variants: a periodization reserve (PER), which allows the firm to defer tax payments for a certain number of years, and an investment reserve (IVR), which postpones tax payments but has the particular goal of allowing the firm to finance investments from untaxed funds. The latter is assumed to include a penalty levied if the reserve is not used to cover investment. We find that PER lowers the effective tax rate and produces a smaller reduction in the firm's cost of capital. The impacts of IVR are more complex. With a low penalty, its effects equal those of PER. In both cases they could be mimicked more easily by a reduction in statutory tax rate. However, with a high penalty and high ceiling for allocations, IVR equals a neutral cash flow tax. Similarly, if the firm distributes maximum dividends (binding dividend constraint), both PER and IVR are investment neutral. These neutrality results only concern investment financed from retained profits.

Key words: corporate tax, investment reserve, cost of capital, investment incentives

JEL classes: H25, H32

Tiivistelmä

Tutkimuksessa tarkastellaan verotuksessa vähennyskelpoisten varausten vaikutuksia kannusteeseen investoida. Tuloksentasausvaraus (PER) tarjoaa mahdollisuuden siirtää osa voitosta määräajaksi verovapaaseen varaukseen. Siirto lykkää yhteisöveron maksamista. Myös investointivaraus (IVR) lykkää verojen maksua, mutta mahdollistaa samalla investointien kattamisen verottamattomista voittovaroista. IVR sisältää sanktion, joka on maksettava, mikäli varaus tuloutetaan (ei käytetä investointeihin). Tutkimuksessa havaitaan, että PER pienentää hieman yrityksen efektiivistä veroastetta ja alentaa investoinnin pääomakustannusta. IVR:n vaikutukset riippuvat varauskaton ja sanktion suuruuksista. Kun toinen näistä on matala, IVR vaikuttaa kuten PER. Sama vaikutus olisi toteutettavissa alentamalla yhteisöverokantaa. Parametrien ollessa riittävän suuria IVR vastaa investointien välitöntä kulukirjausta. Verotuksen vaikutus pääomakustannukseen häviää. Vastaava neutraalisuus toteutuu myös jos yritys jakaa maksimaalisen määrän osinkona. Neutraalisuustulokset koskevat vain pidätetyillä voitoilla rahoitettuja investointeja.

Asiasanat: yhteisövero, investointivaraus, pääomakustannus, kannuste investoida

JEL-luokat: H25, H32

1. Introduction

Economic analysis suggests that investments and capital stock are important determinants of productivity and welfare of a country. Governments of many industrialized countries have indeed searched for efficient ways to spur business investment, corporate taxation being one frequently used means for this purpose: most OECD countries have cut their tax rates over the last few decades, a few have provided accelerated depreciation schemes for equipment and structures (USA, UK, Germany and Finland), and some others have allowed the costs of equity financing to be deductible in corporate taxation (Belgium and Italy).

In Finland, some policy makers and interest groups have advocated the use of tax-deductible reserves to stimulate business investment (Rehn, 2016; Technology industry of Finland, 2015; Holm et al., 2016). Such reserves were in fact an important element of the Nordic corporate tax systems decades ago. They were originally aimed at being tools of counter-cyclical fiscal policy [1] but were later transformed to general measures to promote business investment. These reserves were largely removed in the tax-rate cutting and base-broadening tax reforms of the early 1990s.

Two different forms of reserves have been put forward in the recent Finnish debate. A *periodization reserve* (PER) allows the firm to allocate a share of its pre-tax profit to the reserve. [2] The allocated amount must be returned as taxable income within a predetermined time period. Swedish tax legislation still includes such a reserve. According to the rules for this, the maximum allocation is 25 per cent of pre-tax profit and the reserve should be entered into taxable income after 6 years at the latest.[3]

The second design featured in the recent debate is the *investment reserve* (IVR). Its apparent aim is to allow firms to finance investments from untaxed retained profits. Again, the firm may allocate a share of its pre-tax profit to the reserve and this amount is tax-deductible. Its distinctive feature is that the firm may cover new investment from the funds in the reserve. For such investment, the firm cannot claim depreciation allowances, since investment covered from the reserve are considered to be fully written off for tax purposes. Hence, the firm only adds the amount of the investment net of any amount

[1] The key aspect of Sweden's and Finland's investment reserve systems in this respect was the requirement that to be able to deduct the allocation from taxable income, the firm had to deposit a fraction of the allocated amount in an interest-free blocked account at the central bank. In the recession years the government then permitted firms to withdraw funds from these accounts (and use the reserve) to finance new investment (Agell et al. , 1995).

[2] We use the term 'periodization reserve' following the recommendation by KudoZ Translation Help (http://www.proz.com/kudoz/swedish_to_english/bus_financial/209306-periodiseringsfonder.html). Other terms used in the literature are 'profit reserve' (ZEW, 2015) and 'tax allocation reserve' (Business Sweden 2015).

[3] Under the Swedish rules the opportunity to deduct the allocated amount is not free of charge: a return on the reserve stock is added annually to the firm's taxable income calculated as a product of the after-tax interest rate and the reserve stock. The recent proposals in Finland have not included any such tax cost.

covered from the reserve to its stock of depreciable assets. An alternative way of using the reserve is returning it as taxable income. Again, this should be carried out within some predetermined period. In this case, the system could include a sanction payment to strengthen the incentive to use the reserve to cover investment.[4]

The goal of this paper is to provide intuition to the mechanisms by which the two different designs of tax-deductible reserves affect the firm's incentives to invest. It does this by analyzing the reserve variants in a standard corporate tax model.[5] We are particularly interested in testing whether, and on which conditions, the following two claims of previous debate are accurate. According to the first claim, the PER leads to a (small) reduction in the effective corporate tax rate, and therefore lowers the firm's cost of capital (Lindhe, 2002; ZEW, 2015). The second claim is that the IVR is like immediate expensing of investment. Therefore its effects on investment should be similar to those of a neutral cash flow tax. [6]

In many respects our analysis follows Södersten (1989) and Auerbach et al. (1995), who model the previous Swedish 'Investeringsfond' system in a dynamic framework. We deviate from these studies in several aspects, however. First, we include an analysis of a PER and, second, we drop any institutional elements related to the role of the system as a tool of stabilization policy (such as the interest-free deposits in blocked accounts at the central bank). Third, we augment the tax system in Södersten (1989) by adding the opportunity to add the allocated funds to taxable income instead of only using them against investment. Connected to this aspect, we also introduce a penalty levied to strengthen the incentive for using the reserve to cover investment. Finally, we analyze the deployment decision: whether, and if so, on what conditions the optimizing firm allocates funds to the reserve and uses the existing reserves to cover investment.

Our analysis reveals that, in the presence of a penalty payment, an optimizing firm does not necessarily allocate funds to the reserve or use the existing reserves to cover investment expenditure. We characterize analytically and numerically the conditions on which it does. The analysis shows that the effects of PER can indeed be summarized by a reduction in the effective corporate tax rate, except in one rather special case. The implications of IVR are more complex. They split into a number of cases where the effects

[4] The previous Finnish IVR, effective between 1978 and 1992, included a sanction. If the reserve was not used against investment expenditure, the amount returned as taxable income was factored by 1.2. An obvious alternative means to strengthen the incentive for using the reserve against investment is to provide a grant if the reserve is used in this way.

[5] We focus on investment incentives. Hence we implicitly assume that the cost of capital is an important channel through which taxation affects investment. According to the economic literature, the main alternative factor is net cash flow, Bond and Van Reenen (2007). Recently, Bond and Xing (2015) and Maffini et al. (2016) have provided evidence for the importance of the cost-of-capital channel.

[6] Södersten (1989) calls this the "conventional view" of IVR.

vary depending on various characteristics of the firm and the tax system. One of these determinants is whether the funds released from the reserve are sufficient to cover all new investment, and another is how large is the penalty levied if the reserve is not used against investment. The firm's cost of capital may vary a lot across these regimes. In some cases the investment tax wedge (the difference between the pre-tax rate of return and the interest rate) is zero and in others to varying degrees positive, but lower than in the benchmark case of standard corporate tax.

The paper proceeds as follows. In Sec. 2 we set up the model and in Sec. 3 discuss the reference tax systems (standard corporate tax and corporate cash flow tax). Sec. 4 provides the analysis of PER and IVR assuming that the firm does not pay out the maximum dividends (non-binding dividend constraint). Sec. 5 considers the effects in the opposite case where the firm's dividend constraint is binding. Sec. 6 illustrates the magnitudes of the effects using calculations and Sec. 7 concludes.

2. The Model

To assess the incentive effects of tax-deductible reserves, consider an equity financed value-maximizing firm that produces with homogenous capital, K, as the single input, and finances from profits, $\pi(K)$ ($\pi'(K) > 0$ and $\pi''(K) < 0$). The firm spends its resources on dividends, D, investment, I, and corporate taxes, T:

(1) $$\pi(K) = D + I + T.$$

All prices are normalized to one. The capital stock, K, depreciates at rate $\delta \in (0,1)$, and evolves as follows

(2) $$\dot{K} = I - \delta K.$$

We analyze two distinct types of tax-deductible reserves. In both the firm may allocate an amount C to the reserve. This amount is constrained to a share $f \in (0,1)$ of profit after depreciation, $C \leq f[\pi(K) - \alpha k]$, where α denotes the rate of fiscal depreciation and k is the accounting stock of capital.

We assume the PER to entail an exogenous recovery procedure: at every point in time, a constant share $b \in (0,1)$ of the accumulated reserve stock R is entered as taxable income. This obviously deviates from real-life PERs such as the Swedish "Periodiseringsfond", where the firm may choose, within the limits of the maximum duration, the moment at which the allocated amount is returned as taxable income. However, deferring tax payments is profitable, which implies that an optimizing firm always chooses the maximum length of deferral. This means that both in a true PER and in our model, a share of taxes is deferred and the recovery procedure is defined by the parameters of the system. Then, the model's recovery procedure can be seen as a rough way to approximate the deferral choice of an optimally behaving firm in a true PER. [7]

Under IVR, the funds in the reserve are used either against investment outlay or entered as taxable income through a procedure similar to that in PER. We denote the amount used to cover investment by G.

Now we are ready to write the equation of motion for the reserve stock, R:

(3) $$\dot{R} = C - G - bR.$$

The accumulated reserve R increases with new allocations to the reserve, C, and decreases with the use of the reserve against investment, G, and the gradual decay of the stock at rate b. Under IVR $G \geq 0$, while under PER always $G = 0$.

The equation of motion for the accounting stock of capital k is:

(4) $$\dot{k} = I - G - \alpha k.$$

Hence k increases with new investment, I, net of any amount covered from the reserve, G, and decreases with fiscal depreciation, αk. The rate of fiscal depreciation is allowed to be "accelerated", i.e. the rate may be higher than the rate of true economic depreciation, i.e. $\alpha \in [\delta, 1)$.

The firm's tax bill T reads as follows:

(5) $$T \equiv \tau[\pi(K) - \alpha k - (C - zbR)],$$

where $\tau \in (0, 1)$ is the rate of corporate tax and the element in brackets is taxable income. The latter is calculated as operating profit minus fiscal depreciation allowances, αk, minus allocations to the reserve net of the amount entered as taxable income, $C - zbR$. We assume that the tax base is always positive.

Observe that in (5) the automatic decay, bR, is factored by $z \in [1, \infty)$. This factor is introduced in order to model a tax penalty, levied if the IVR is not used against investment but rather entered into taxable income. It takes the value of $z = 1$ if there is no penalty, and $z > 1$ if there is penalty.

We set up the following constraints for C, R and G:

[7] One important reason for making this assumption is that, in a dynamic model, it is not easy to link the amount allocated at time $t - s$ to the amount that should be entered as taxable income at time t. Here s denotes the holding period.

(6) $$0 \leq C \leq f[\pi(K) - \alpha k], \;\; R \geq 0, \;\; 0 \leq G \leq I.$$

All the variables are non-negative. Additionally, C is constrained to the share f of profit net of fiscal depreciation, and G to the amount invested I. In what follows, we denote these ceilings: $C^{max} \equiv f[\pi(K) - \alpha k]$ and $G^{max} \equiv I$

Next we discuss a constraint for dividends which is a consequence of requirements in company law. Current Finnish law demands that distributions do not violate the liquidity of the corporation nor exceed the free equity capital of the balance sheet of the firm. In combination with the tradition of uniform accounting, which requires that items to be deductible in tax accounts must first be deducted in commercial accounts, the free-equity requirement implies that dividends may not exceed the profit after fiscal depreciation, net contributions to the reserve and taxes:

(7) $$D \leq \pi(K) - \alpha k - (C - cbR) - T.$$

This constraint represents the type of legal constraint on dividends traditionally applied in the Scandinavian countries, and analyzed e.g. in Södersten (1989) and Kanniainen and Södersten (1995). As we will show in Sec. 5, the constraint transforms to a constraint on allocations to the reserve. If taken literally, the constraint (7) can be binding only in the extreme situation, where all accumulated profits on the firm's balance sheet (free equity capital) have been run down already and the firm must rely on current profits to finance distributions.

In the model, the firm maximizes the present value of its cash flow to the owners

$$V(0) = \int_0^\infty De^{-\rho t}dt,$$

subject to the constraints and definitions in eqs. (1) - (7). ρ denotes the firm's after-tax discount rate.[8]

The Lagrangean of the problem is

$$L = D + \mathrm{q}_1[(1-\tau)\pi(K) - D + \tau(\alpha\mathrm{k} + \mathrm{C} - \mathrm{zbR}) - \delta\mathrm{K}] + \mathrm{q}_2[(1-\tau)\pi(K) - D + \tau(\alpha\mathrm{k} + \mathrm{C} - \mathrm{zbR}) - \alpha k - \mathrm{G}] + \mathrm{q}_3[C - G - bR] + \mu_1 C + \mu_2\{f[\pi(K) - \alpha k] - C\} + \mu_3 R + \mu_4 G + \mu_5[(1-\tau)\pi(K) - D + \tau(\alpha\mathrm{k} + \mathrm{C} - \mathrm{zbR}) - G] + \mu_6\{(1-\tau)[\pi(K) - \alpha\mathrm{k} - \mathrm{C}] + (1 - \mathrm{z}\tau)\mathrm{bR} - \mathrm{D}\},$$

where $q_1 - q_3$ are the co-state variables for the state variables K, k and R, respectively, and $\mu_1 - \mu_6$ are shadow prices of the constraints in eq. (6) and eq. (7), respectively.

[8] We ignore owner-level taxes, since they are likely to have a minor impact on the effects of the reserve systems.

The first-order conditions are

(8a) $\frac{\partial L}{\partial D} = 1 - \mathrm{q}_1 - \mathrm{q}_2 - \mu_5 - \mu_6 = 0$

(8b) $\frac{\partial L}{\partial C} = \tau(\mathrm{q}_1 + \mathrm{q}_2 + \mu_5 + \mu_6) + \mathrm{q}_3 + \mu_1 - \mu_2 - \mu_6 = 0$

(8c) $\frac{\partial L}{\partial G} = -\mathrm{q}_2 - \mathrm{q}_3 + \mu_4 - \mu_5 = 0$

(8d) $\dot{q}_1 = (\rho + \delta)\mathrm{q}_1 - (1-\tau)\pi'(\mathrm{q}_1 + \mathrm{q}_2 + \mu_5 + \mu_6) - f\pi'\mu_2$ (K)

(8e) $\dot{q}_2 = \rho \mathrm{q}_2 - \tau\alpha(\mathrm{q}_1 + \mathrm{q}_2 + \mu_5 + \mu_6) + \alpha \mathrm{q}_2 + f\alpha\mu_2 + \alpha\mu_6$ (k)

(8f) $\dot{q}_3 = \rho \mathrm{q}_3 + \tau z\mathrm{b}(\mathrm{q}_1 + \mathrm{q}_2 + \mu_5 + \mu_6) + \mathrm{b}\mathrm{q}_3 - \mu_3 - \mathrm{b}\mu_6.$ (R)

By using $\mathrm{q}_1 + \mathrm{q}_2 + \mu_5 + \mu_6 = 1$ in (8a), equations (8b), (8d), (8e) and (8f) can be rewritten:

(8b’) $\frac{\partial L}{\partial C} = \tau + \mathrm{q}_3 = \mu_2 - \mu_1 + \mu_6$

(8d’) $\dot{q}_1 = (\rho + \delta)\mathrm{q}_1 - (1-\tau)\pi' - f\pi'\mu_2$

(8e’) $\dot{q}_2 = (\rho + \alpha)\mathrm{q}_2 - \tau\alpha + f\alpha\mu_2 + \alpha\mu_6$

(8f’) $\dot{q}_3 = (\rho + \mathrm{b})\mathrm{q}_3 + \tau c\mathrm{b} - \mu_3 - \mathrm{b}\mu_6.$

We conclude this section by summarizing the differences between the reserve types. While in the case of PER $G = \mu_4 = \mu_5 = 0$ and $z = 1$, under IVR all these variables may take positive values as follows: $G \geq 0, \mu_4 \geq 0, \mu_5 \geq 0$ and $z \geq 1$[9].

3. Reference case: standard corporate tax without any form of reserve

To establish a point of reference, we start from a case where no tax-deductible reserves are available to the firm. This case can be analyzed by setting C, G and R, and the shadow prices, $\mu_1 - \mu_6$ and q_3, to equal zero. This means that we only have three first-order conditions, (8a), (8d’) and (8e’), and two co-states, q_1 and q_2.

The effects of taxation on investment incentives are analyzed by considering the marginal condition for the optimal capital stock in the long-run equilibrium, i.e. the cost of capital. It

[9] The penalty factor is allowed to take the value $z = 1$ as a special case of IVR.

gives the minimum gross rate of return on investment required by the owners of the firm.[10]

By substituting $q_1 + q_2 = 1$ from (8a) to (8d') and solving the resulting condition for $\pi'(K)$ gives the following condition for the optimal capital stock:

(9) $$\pi'(K) = \frac{q_1}{1-\tau}(\rho + \delta).$$

Again using $q_1 + q_2 = 1$ and solving eq. (8e) for q_2 we obtain:

$$q_2 = \frac{\tau\alpha}{\alpha+\rho} \equiv \tau A.$$

where $A \in (0,1)$ is the present value of fiscal depreciation allowances on a unit of capital calculated at the firm's discount rate ρ. Therefore, q_2 gives the present value of tax savings from fiscal depreciations, and $q_1 = 1 - q_2$ in eq. (9) the net cost of acquiring an asset of unit value.

Using these results we may rewrite eq. (9) as follows:

(9') $$\pi'(K) = \frac{1-\tau A}{1-\tau}(\rho + \delta),$$

where the right-hand side (rhs) is the standard expression for cost of capital (King and Fullerton, 1984; Devereux and Griffith, 2003). Corporate taxation affects the incentives to invest through two channels: first, it reduces the return on marginal investment, reflected by $1-\tau$ in the denominator of the quotient term, and second, it reduces the cost of investment, $1-\tau A$ in the numerator. The quotient term is sometimes called the tax component of the cost of capital (Bond and Xing, 2015).

In the special case of immediate expensing of investment, we obtain $A = 1$. When we substitute this into eq. (9'), the tax component disappears. This demonstrates that corporation tax has no effect on the cost of capital under cash flow tax. The intuition of this result is that immediate expensing exempts the marginal return (normal return) on capital from taxes and tax only falls on economic rents. In that situation all projects that are profitable (unprofitable) in the absence of taxation are also profitable (unprofitable) when taxes are levied.

4. Reserves under non-binding dividend constraint

[10] In the analytical part of this paper, we use the cost of capital before economic depreciation due to the relative simplicity of its formulae. In Sec. 6, we shift to using its companion concept cost of capital after economic depreciation, which is the standard in calculations (e.g. King and Fullerton, 1984).

We start the analysis from the case where the constraint on dividends (eq. (7)) is non-binding. The essential implication of this is that dividend payments do not constrain the amount allocated to the reserve. Hence the firm may freely choose the size of allocations from the range $0 \leq C \leq C^{max}$. From the non-bindedness of the dividend constraint it follows that $\mu_6 = 0$.

4.1 Periodization reserve, PER $(G = 0, z = 1)$

The characteristic feature of PER is that the only way to release the funds in the reserve is to return them as taxable income. This means that the reserve cannot be used to cover investment expenditure ($G = 0$), and there is no tax penalty ($z = 1$). The first property implies that the shadow prices for the floor and ceiling of G can be dropped ($\mu_4 = \mu_5 = 0$).

Optimal choice of C

Let us first consider whether the firm faces an incentive to allocate a share of its profit to the reserve. This can be studied by considering condition (8b'). It compares the costs and benefits from a one unit increase in C. If the left-hand side (lhs) of the equation is positive, we have $\mu_2 > 0$ and $\mu_1 = 0$. This implies that the firm allocates the maximum amount into the reserve. In the opposite case, $\mu_1 > 0$ and $\mu_2 = 0$, implying that the firm chooses $C = 0$.

By considering condition (8f') in the steady state, using $\mathrm{q}_1 + \mathrm{q}_2 = 1$ from (8a), and solving the resulting equation for q_3, gives $\mathrm{q}_3 = -\frac{\tau b - \mu_3}{\rho + b}$. Inserting this into (8b'), we obtain:

(10) $$\tau + \mathrm{q}_3 = \tau(1 - B) + \frac{\mu_3}{\rho + b} = \mu_2 - \mu_1,$$

where $B \equiv \frac{b}{\rho + b} \in (0, 1)$ is the present value of a one unit of profit the taxation of which is delayed due to allocation to the reserve. Increasing C produces an immediate saving, τ, and a cost measured by q_3. The latter gives the present value of taxes deferred when one unit is allocated to the reserve. Since $B < 1$ and $\mu_3 > 0$, we obtain $\mu_2 > 0$ and $\mu_1 = 0$. This implies, that the firm chooses the maximum allocations, $C = C^{max}$.

With maximum allocations and only slow gradual redemption, we necessarily have $R > 0 => \mu_3 = 0$. Using this result we obtain $q_3 = -\tau B$. Hence a one-unit increase in C leads to a net saving of $\mu_2 = \tau(1 - B) > 0$.

Using this and eq. (8a), eq. (8e') can be solved to give:

(11) $$q_2 = [(1 - f)\tau + f\tau B]A,$$

where A is as defined in Sec. 3.

The cost of capital

We are now ready to derive the cost of capital under PER. Using eq. (8a) and substituting the values of μ_2 and q_2 into eq. (8d') we obtain:

(12) $$\pi'(K) = \frac{1-e_{per}A}{1-e_{per}}(\rho+\delta).$$

where $e_{per} \equiv (1-f)\tau + fB\tau$ is the effective corporate tax rate. The only difference between equations (12) and (9) is that the effective tax rate e_{per} is now substituted for the legal tax rate τ in (9).

We suggest the following economic interpretation for e_{per}: as B is the present value of deferred profit, it gives the weighted average of instantly paid tax and the present value of delayed taxes, with the share of profit taxed instantly, $1-f$, and the share for which taxation is delayed, f, as weights.

The effective tax rate can be rewritten:

(13) $$e_{per} = \tau - f\tau(1-B) < \tau,$$

This expresses e_{per} as the statutory tax rate reduced by the saving from deferring the taxation of share f of one unit of profit. Since $\tau, B, f \in (0,1)$, e_{per} is necessarily lower than the statutory rate.

In sum, the relevant tax rate that affects the returns and costs of investment is the effective rate, which is strictly lower than the statutory tax rate. This implies that the cost of capital is scaled down compared to the standard case. In Sec. 7 we demonstrate that the magnitude of the effect is modest, if not small. These results suggest that the effects of PER in investment incentives could be mimicked by reducing the statutory rate.

To our knowledge, eq. (12) has not been derived in an optimization framework before, but it is still familiar from some previous studies. ZEW (2015) derives e_{per} heuristically and uses the result in their analysis of the effects of taxes on investment in the EU. Hence, eq. (12) provides a justification for the way ZEW (2015) models the Swedish PER. In Sec 5 we will nonetheless observe that this result is not the whole story on the effects of PER. The outcome changes a lot when we assume a binding dividend constraint.

4.2 Investment reserve, IVR ($G \geq 0, z \geq 1$)

4.2.1 Optimal C and G

Unlike in section 4.1, now the firm may choose between using the reserve to cover investment and letting the reserve automatically decay at rate b. Therefore, there are two choices which we should analyze: how much does the firm allocate to the reserve, C, and how does it use the reserve, G? As we will see, these decisions are not independent. On certain conditions, the way the reserve is used affects the optimal allocation.

The optimal C can again be studied by considering eq. (8b'). Assume that there are no shortage of funds in the reserve, $R > 0$ => $\mu_3 = 0$ and solve (8f') for q_3. Inserting this result into (8b') gives:

(10') $$\tau(1 - zB) = \mu_2 - \mu_1.$$

As in Sec. 4.2, the left-hand side (lhs) compares the benefits and costs of a one unit increase in tax-deductible allocations. However, now the term in parenthesis is not necessarily positive. The present value of delayed profits, $B < 1$, is factored by the penalty factor, $z \geq 1$. At a sufficiently high value of z the term is negative. Therefore, we have two opposite optimal policies depending on the size of the penalty factor z (when we keep B as given and dismiss the borderline case where the firm is indifferent):

(i) Low or medium penalty, $z < \frac{1}{B}$: $\mu_2 > 0, \mu_1 = 0$ => $C = C^{max}$

(ii) High penalty, $z > \frac{1}{B}$: $\mu_1 > 0, \mu_2 = 0$ => $C = 0$

Hence, if z is lower than the threshold, the firm maximizes tax-deductible allocations into the reserve. Instead, with a higher penalty factor than the threshold, the firm minimizes the allocations.

However, these results are only effective if the reserve is used by entering the funds into taxable income in the margin. Hence the condition for the optimal choice of C depends on the way the funds are used.

We will demonstrate this using the following example. Assume that the firm uses the reserve to cover investment outlay and that C^{max} is so low that it cannot cover all investment $C = G < G^{max}$. The property $G < G^{max}$ implies that $\mu_4 = \mu_5 = 0$, and further, by condition (8c), that $q_3 = -q_2$. Inserting this into (8e') we obtain the following expression for q_2:

$$q_2 = \tau A' + \mu_1 \frac{f\alpha}{\rho + (1-f)\alpha}.$$

where $A' \equiv \frac{(1-f)\alpha}{\rho+(1-f)\alpha} \in (0,1)$. Using these results we may rewrite the condition for optimal C as follows:

(10'') $\tau - q_2 = \mu_2 - \mu_1 \;=>\; \tau(1-A') = \mu_2 - \left(1 - f\frac{\alpha}{\rho+(1-f)\alpha}\right)\mu_1.$

The lhs of (10'') is strictly positive, implying that $\mu_2 > 0 \;=>\; C = C^{max}$. The firm maximizes the tax-deductible allocations. Observe that the condition is independent of the penalty factor z. The intuition for this is that, as assumed, the reserve is used against investment in the margin, and no penalty is due. Therefore, the parameters linked to returning the reserve as taxable income do not matter.

Let us move on to the optimal size of G. This can be studied using condition (8c). Assume that the firm has an incentive for allocating funds to the reserve, $\mu_2 > 0$ and that the reserve has funds, $R > 0 => \mu_3 = 0$. Solving eq. (8f') for q_3 and eq. (8e') for q_2, using μ_2 from (8b') and substituting the results into eq. (8c) gives:

(14) $q_2 + q_3 = (1-f)\tau A - \tau z B(1 - fA) = \mu_4 - \mu_5$

The condition compares the costs (q_2) and benefits (q_3) from using the reserve to cover investment. While q_2 gives the cost from lost depreciation allowances, q_3 measures the tax saving from not entering the reserve as taxable income. If the lhs is negative, $\mu_5 > 0$, implying that the firm uses the reserve on investment. In the opposite case, the firm sets $G = 0$.

By arranging terms, we obtain the conditions for two different policies depending on the size of the penalty factor, z [11]

(i) Low penalty, $z < \frac{A'}{B}$: $G = 0$

(ii) Medium or high penalty, $z > \frac{A'}{B}$: $G = G^{max}$

At a low penalty (including no penalty at all) the firm does not use the reserve to cover investment. It rather enjoys the benefits from tax-deductible allocations and lets the reserve be returned as taxable income through the automatic decay procedure. With a sufficiently high (medium or high) penalty the firm faces an incentive to use the reserve to cover investment.

Hence, with a low penalty rate, the firm does not use the reserve to cover investment expenditure. This observation provides the normative suggestion that the investment reserve system should include a sufficiently high sanction in order to guide the firm to use

[11] We again skip the '=' case where the firm is indifferent with respect to the size of G.

the reserve to fund investment. If this is not done, IVR functions like PER, and all the detailed rules concerning the use of the reserve to cover investment could be repealed.

4.2.2 The cost of capital

Next we start analyzing the effects of IVR on investment incentives. We continue assuming that the dividend constraint (eq. (7)) is non-binding. We will focus on four different cases with different implications for the firm's investment decisions. In Appendix, these cases are shown to be feasible in the assumed IVR system. In Table 1 we illustrate the differences between the four cases using two aspects of the tax system: the size of the penalty factor, z, and the level of the ceiling for allocations, C^{max}.

Table 1. Characteristics of the four cases

Maximum allocation, C^{max}	**Penalty factor, z**		
	Low, $1 \leq z < \frac{A}{B}$	**Medium, $\frac{A'}{B} \leq z < \frac{1}{B}$**	**High, $z \geq \frac{1}{B}$**
Low, $C^{max} < G^{max}$	Case 1	Case 2	Case 2
High, $C^{max} > G^{max}$	Case1	Case 3	Case 4

The penalty factor is classified to three levels: low, medium and high. The size of the maximum allocations has two classes: low and high. Case 1 is effective if the penalty is low. While case 2 is effective if the ceiling C^{max} is low and the penalty mid-sized or high, case 3 is effective with a high ceiling and a mid-sized penalty. Finally, case 4 occurs when both C^{max} and z are high.

Case 1: Low penalty, high or low C^{max} $(1 \leq z < \frac{A}{B})$

We start from case 1 which is effective if the penalty rate is sufficiently low. Due to the low penalty $z < \frac{A}{B}$ the firm allocates the maximum amount to the reserve, $C = C^{max}$, but no share of the reserve is used against investment, $G = 0$. The firm lets the reserve be returned as taxable income through the automatic decay procedure. These properties imply that $\mu_1 = \mu_5 = 0$ and $\mu_2, \mu_4 > 0$. The reserve stock is positive, $R > 0 => \mu_3 = 0$. Using these properties, conditions (8b'), (8f') and (8a) can be rewritten

(8b'') $\quad \mu_2 = \tau + q_3 > 0,$

(8f'') $\quad q_3 = -\frac{\tau z b}{\rho + b} = -\tau c B$

(8a') $\quad q_1 = 1 - q_2.$

Condition (8e') can now be solved for q_2 to give:

(11'') $\qquad q_2 = [(1-f)\tau - f\tau zB]A$

Using eqs. (8b''), (8f''), (8a') and (11''), we can write eq. (8d') as:

(12') $\qquad \pi'(K) = \frac{1-e_{ivr1}A}{1-e_{ivr1}}(\rho+\delta),$

where $e_{ivr1} = (1-f)\tau - f\tau zB$ is the effective tax rate.

As under PER, both the marginal return and the effective cost of investment are reduced by the effective tax rate. The only difference from Sec. 4.1 is the penalty factor z in the second term of e_{ivr1}. Since $1 \leq z < \frac{A}{B}$, the effective tax rate e_{ivr1} has the following properties: $e_{per} \leq e_{ivr1} < \tau$.

The similarity to PER derives from the similar use of the reserve. The detailed rules specific for IVR have either no or just a small effect on behavior.

Case 2: High or medium high penalty and low C^{max} ($\frac{A'}{B} \leq z < \frac{1}{B}, C^{max} < G^{max}$)

Let us next consider the case where the penalty factor is sufficiently high so that the firm uses the reserve to cover investment. However, C^{max} is assumed to be so small that the funds in the reserve only suffice to cover a fraction of investment. Hence neither constraint of G is binding, $0 < G < G^{max}$ => $\mu_4 = \mu_5 = 0$. The shortage of funds in the reserve implies that $C = C^{max}$ => $\mu_2 > 0$ and $R = 0$ => $\mu_3 > 0$.

Conditions (8a) and (8c) now are:

(8a'') $\qquad q_1 + q_2 = 1 \leftrightarrow q_1 = 1 - q_2$

(8c') $\qquad -q_2 = q_3$

Using these results, eq. (8b') becomes:

(8b''') $\qquad \mu_2 = \tau - q_2.$

By inserting this and $q_1 + q_2$ into eq. (8e') and solving for q_2, we obtain:

(11''') $\qquad q_2 = \tau\frac{(1-f)\alpha}{(1-f)\alpha+\rho} = \tau A'.$

By solving (8d') for $\pi'(K)$ and arranging the terms we obtain the following expression for the cost of capital:

(12'') $\qquad \pi'(K) = \frac{1-e_{ivr2}A}{1-e_{ivr2}}(\rho+\delta),$

where $e_{ivr2} = (1-f)\tau + f\tau A'$. The new effective tax rate e_{ier2} is a weighted average of the statutory rate and the increased tax due to the loss of regular depreciation allowances with $1-f$ and f as weights.

Observe that B or z do not figure in the expression of e_{ivr2}. The apparent reason is that all funds in the reserve are used to cover investment. No share of it is returned as taxable income with penalty. Instead of zB, the expression includes $\tau A'$. From using the reserve against investment it follows that the firm loses the regular depreciation allowances. This loss leads to a tax cost of $\tau A'$per one unit allocated (and then released to cover investment).

The cost of capital in (12'') is analogous to 'regime 3' in Södersten (1989). The differences derive from the institutional differences. Södersten calls this result the "new view" of IVR in contrast to the "conventional view", proposed by some earlier studies. These studies saw IVR as having equivalent effects to immediate expensing. The essential aspect of this "new view" is that marginal investment is not directly affected by the reserve. The effects rather work indirectly through the effective tax rate.

Case 3: Medium high penalty and high C^{max} ($\frac{A'}{B} < z < \frac{1}{B}$, $C^{max} > G^{max}$)

Now we consider a case where the penalty factor is medium sized. It is sufficiently high so that the firm faces an incentive to use the reserve to cover investment and it is sufficiently low to encourage the firm to make a maximum allocation to the reserve. Among the aspects is also that C^{max} is so high that the firm can cover all investment expenditure from the reserve. These features imply: $G = G^{max}$ => $\mu_5 > 0$ and $C = C^{max}$ => $\mu_2 > 0$. The abundance of funds in the reserve implies that $R > 0$ => $\mu_3 = 0$.

These properties imply that conditions (8b'') and (8f'') are still effective, but conditions (8c) and (8a) take the following forms:

(8c'') $\quad q_2 + \mu_5 = -q_3$

(8a''') $\quad q_1 = 1 - q_2 - \mu_5 = 1 + q_3 = 1 - \tau z B$.

Using these results, condition (8d) can be solved for π' to yield:

(12''') $\quad \pi'(K) = \frac{1-\tau z B}{1-e_{ivr1}}(\rho + \delta)$.

Now taxation affects the costs and returns asymmetrically. The relevant tax rate that affects the net returns is e_{ivr1}. This is apparently related to the fact that the firm allocates the maximum amount to the reserve. As a result both the average and the marginal tax rate is reduced because of deferral of the maximum share of profit.

An even more notable feature of (12''') is that the cost of investment is reduced by $\tau z B$, which is independent of depreciation allowances. That depreciation allowances have no effect is intuitive, since marginal investment is covered from the reserve and, therefore, is not expensed through ordinary fiscal depreciation system. But why is $\tau z B$ in the numerator? The apparent explanation is the following: when the firm covers all investment from the reserve, it loses the tax savings from depreciations but avoids the additional taxes it should pay if the reserve were entered as taxable income and not used against investment. So, it saves the amount $\tau z B$ per each unit of marginal investment.

Observe that the cost of capital becomes sensitive to the size of z. At a high z, the effective cost of investment is low and so is the cost of capital.

The cost of capital in eq. (12''') is analogous to the one Södersten (1989) derives for the case, where the "release of funds" from the reserve is sufficient to cover all investment.[12] It is one of the key results of that paper. In our framework, the case has a more restricted role: it is only effective on the condition $\frac{A'}{B} < z < \frac{1}{B'}$, and therefore it is just one of the three cases where the firm is able to cover all investment from the reserve.

Case 4: High penalty and high C^{max} ($z > \frac{1}{B}$, $C^{max} > G^{max}$)

Now we consider the case where both the penalty factor z and the ceiling for allocations C^{max} are high and, therefore, the firm has an incentive and the resources to cover all new investment from the reserve, $G = I$. However, in contrast to case 3, the firm does not allocate the maximum amount to the reserve. It only allocates $C = G < C^{max}$ which is explained by the high penalty, $z > \frac{1}{B}$. The high penalty encourages the firm to avoid allocations that exceed the amount used for covering investment.

These features imply that $\mu_1 = \mu_2 = \mu_4 = 0$ and $\mu_5 > 0$.

Using these, we may rewrite the three first optimality conditions as follows:

(8a''') $\quad q_1 = 1 - q_2 - \mu_5$

(8c'') $\quad q_2 + \mu_5 = -q_3$

(8b'''') $\quad -q_3 = \tau.$

Using (8b'''') and (8c''), eq. (8a''') reduces to $q_1 = 1 - \tau$.

[12] Regime 2 in Södersten (1989).

The marginal condition for investment becomes:

(12''') $$\pi'(K) = \frac{1-\tau}{1-\tau}(\rho + \delta) = \rho + \delta.$$

The quotient term on the rhs cancels out, which implies that taxation has no effect on the incentive to invest. Corporate tax is neutral with respect to investment. This result is new and deviates from Södersten (1989).

The apparent explanation for the result is that the system works like immediate expensing under a CFT. A one unit increase in investment is accompanied with a one-unit increase in $C = G$. The increase in tax-deductible allocations triggered by the investment corresponds to immediate expensing and results to a net investment cost of $1 - \tau$.

It may be worthwhile to discuss the ingenuity of this case in short. The assumed high penalty means that the firm is not willing to allocate more than is used against investment. This, together with the high ceiling, means that the firm possesses underutilized tax allowances. If the firm increases its investments by one unit it faces an incentive to increase G and C by the same amount (one unit). Due to this one-unit additional allocation the firm obtains a tax saving of the size τ. The reserve is not just a general tax allowance, but rather affects the marginal investment directly.

The result of this case is desirable from the policy point of view. Therefore, an IVR system should include a high penalty and a high ceiling for allocations. If this is satisfied corporate tax does not distort investment. Compared to CFT, the IVR system seems inferior, however. While CFT yields neutrality independently of the way investment is financed, IVR only (or mainly) targets investment financed from retained earnings.

5. Binding dividend constraint

General

In the previous sections we assumed that the amount of dividends is so small that the constraint on dividend payments set up in eq. (7) is non-binding. Södersten (1989) and Kanniainen and Södersten (1995) suggest that such dividend constraints can have important implications for the incentive effects produced by special tax allowances. They argue that with a binding constraint the tax system is neutral with respect to investment, i.e. displays the properties of a CFT.

Consider a firm that only uses its IVR to cover investment expenditure, i.e. $zbR = 0$. Using this and the definition for T in eq. (5), the dividend constraint in (7) can be rewritten:

(7’) $C \leq \pi(K) - \alpha k - D/(1-\tau)$

Hence the dividend constraint can be seen as a constraint on allocations. If condition (7’) is binding it crowds out the original ceiling of C in condition (6).

By inserting D from the firm’s budget equation (1) into (7’) and assuming a binding constraint, we further obtain:

(15) $C = I - \alpha k.$

This gives the relationship between C and I, which will be useful when we later interpret our results. In particular, since k is constant in the short run and assuming the dividend constraint stays binding, a change in I requires a change of the same size in C, $dI = dC$.

The neutrality argument

The analysis in the following focuses on IVR in a situation, where $C < C^{max}$ and $G = I$. However, that the key results also apply to PER and to the IVR case $G < I$. The assumptions imply that $\mu_1 = \mu_2 = \mu_4 = 0$ and $\mu_6 > 0$. The three first optimality conditions are:

(8a’’’’) $q_1 + q_2 + \mu_5 + \mu_6 = 1$

(8b’’’’’) $\mu_6 - q_3 = \tau$

(8c’’) $q_2 + \mu_5 = -q_3$

Insert $\mu_6 - q_3$ from (8b’’’’’) and $q_2 + \mu_5$ from (8c’’) into (8a’’’’) and solve for q_1 to obtain $q_1 = 1 - \tau$.

Using these results, we again get the following marginal condition for investment:

(12’’’) $\pi'(K) = \frac{1-\tau}{1-\tau}(\rho + \delta) = \rho + \delta.$

The cost of capital is invariant to taxation, implying that taxation has no effects on the incentive to invest. This result equals that of the corresponding case in Södersten (1989).

The intuition of the result is as follows. Consider an increase in investment by 1 euro financed from a cut in dividend distributions (i.e. from retained earnings). By condition (7’) the reduction in dividends allows the firm to increase the allocations to IVR. The size of the increase in C is one euro ($dC = dI$, see the paragraph after eq. (15)), the resulting reduction in taxes τ euros and the reduction in dividends is 1- τ euros (see eq. (7’)). Hence the one-unit investment is financed from reduced taxes (τ) and a cut in dividends (1-τ).

The project provides a flow of income, which is taxable in the margin. This is because the binding dividend constraint blocks any increases in tax allowances. This means that the neutrality result is not a product of eliminating the taxation of marginal returns. Rather it derives from the tax treatment of the investment. Analogously to the case 4 above, the one-unit increase in tax-deductible allocations facilitated by the cut in dividends exactly corresponds to immediate expensing of investment under a cash flow tax. In both, the effective cost of marginal investment is $1-\tau$ (in the numerator of the quotient term of eq. (23)) and this equals the net-of-tax rate on returns (in the denominator). As a result the quotient term cancels out, showing that taxation has no effects on investment.

However, while interesting and in some circumstances possibly also useful, this case looks rather extreme to us. At least in the present model, it can only be effective if the firm has run down all free equity and is forced to finance maximum dividends from net profits. Firms in such a position might exist, but they should be just a small minority of the whole corporate sector.

6. Calculations

In this section we illustrate the magnitude of the effects using calculations. We start from the threshold levels of the penalty factor z and the values of the effective tax rates, and then continue to the cost of capital.

Parameter b and penalty factor z

Table 2 presents the threshold levels of the penalty factor, $z^1 = \frac{A'}{B}, z^2 = \frac{A}{B}$ and $z^3 = \frac{1}{B}$, and the effective tax rates, e_{per}, e_{ivr1} and e_{ivr2}, using three levels of interest rate.

We assume an investment in machinery which is depreciated using the declining balance method. This asset depreciates at rate δ = 0.20 and the rate of fiscal depreciation is α = 0.25. The statutory tax rate is τ = 0.2. The maximum share of profit that can be allocated to the reserve is f = 0,25 and the value of deferred profit (parameter B) is assumed to correspond to the present value of profit deferred for 10 years. To calculate e_{ivr1}, one has to assume a value for z that satisfies $z \in [z^1,\ z^3]$**.** The midpoint of this range is applied in Table 2 and Table 3 **(**IVR case 3). We further assume that there is no inflation in the economy.

Table 2. Penalty factor and effective tax rate (%) at three levels of interest rate

Parameter	**Interest rate, ρ** **3%**	**5%**	**7%**
$\boldsymbol{z^1 = A'/B}$	1.16	1.29	1.43
$\boldsymbol{z^2 = A/B}$	1.20	1.36	1.54
$\boldsymbol{z^3 = 1/B}$	1.34	1.63	1.97
$\boldsymbol{e_{per}}$	18.7	18.1	17.5
$\boldsymbol{e_{ivr1}}$	19.1	18.6	18.2
$\boldsymbol{e_{ivr2}}$	19.3	18.9	18.6

Effective tax rate under periodization reserve e_{per} is 17.5 % - 18.7 %. e_{ivr1} is slightly higher, 18.2 % - 19.1 %, which is explained by the penalty factor z in the expression of e_{ivr1} (see the paragraph after eq. (12')). e_{ivr2} is 18.6 % - 19.3 %, i.e. still closer to the statutory tax rate.

Table 2 calculates the cost of capital for the benchmark tax systems and the different reserve models. The cost of capital concept we calculate is cost of capital after economic depreciation. [13] For standard corporation tax (current tax system) we use two statutory tax rates 20 % and 18 %. We assume the interest rate is ρ = 5 %.

[13] We make a slight deviation from the concepts of previous sections. Here we calculate the cost of capital after economic depreciation: $p = \pi'(K) - \delta$.

Table 3. Cost of capital in benchmark tax systems and reserve models, when ρ = 5 %

Type of tax system	**Cost of capital, %**
Standard corporate tax, τ=20%	6.04
τ=18%	5.91
Cash flow tax	5.00
PER	5.92
IVR Case 1	5.95
IVR Case 2	5.97
IVR Case 3	5.21
IVR case 4	5.00
Per and IVR, binding div. constr.	5.00

As discussed in sections 3 – 5 above, under CFT, IVR 4 and the binding dividend constraint case, the cost of capital corresponds to the interest rate. Hence, taxation has no effect on the required rate of return on investment. PER and IVR cases 1 and 2 have a cost of capital that is between the two variants of standard corporate tax (20 % and 18 %). IVR case 3 is sensitive to the size of z. At current parameter values the cost of capital is close to the interest rate but even small changes in z affect the outcome.

7. Summary

This paper models two forms of tax-deductible reserves to analyze their effects on investment incentives. The first variant, the periodization reserve (PER), is designed to allow the firm to defer the taxation of a fraction of its pre-tax profit. Also the investment reserve (IVR) facilitates deferral but its apparent aim is to provide a tax-free source for financing investment. Therefore, the firm is expected to cover investment expenditure from the funds in the reserve. In our model the funds in the reserve may alternatively be released by entering them as taxable income. To improve the incentives for using the reserve on investment, the firm is liable to pay a penalty if the reserve is not used according to the main aim.

We observe that the effect of PER primarily is that it reduces the firm's effective tax rate. This leads to a smaller reduction in the firm's cost of capital. This effect could more easily be mimicked through a reduction in the statutory tax rate.

The implications of IVR are more complex. They are shown to depend on two issues: the size of the penalty and the size of the ceiling for tax-deductible allocations. With a low penalty the firm allocates funds to the reserve but does not use them to cover investment. The reserve becomes equivalent to PER. The effective corporate tax rate and the cost of capital fall slightly.

When the ceiling for allocations is so small that the reserve only suffices for covering a part of new investment, the effects, again, can be summarized by a slight reduction in the effective tax rate. In this case, the reason for a small effect is that the reserve is too small to affect the marginal investment directly.

Instead, with a high ceiling for allocations and mid-size or high penalty, the effects become more prominent. With a mid-size penalty, taxation affects asymmetrically the costs and returns of marginal investment. A particular property of this case is that the effects become quite sensitive to the size of the penalty. However, with realistic parameter values the cost of capital is only slightly higher than the interest rate.

Finally, with a high penalty and a high ceiling the effects of IVR correspond to those of immediate expensing of investment. Hence, as a cash flow tax, the system is neutral with respect to investment. This favorable result suggests that an IVR system should be equipped with a high penalty and a high ceiling for allocations.

We also analyze a special case, where the firm pays dividends to the extent that the "free-equity constraint" established by company law on dividend payments is binding. It turns out that also in this probably rather rare case corporate taxation is neutral with respect to investment. This result holds for both reserve types.

Some of the results are analogous to those of Södersten (1989), which studies the former Swedish IVR system. However, previous literature seems not to have derived the cost of capital for PER, nor has it analyzed the effects of an IVR system which includes an opportunity to return the reserve as taxable income, possibly equipped with a penalty. In particular, the neutrality result in the case where the penalty is high and the firm covers all investment is new.

From the policy point of view this paper draws a picture of the reserve systems that is not particularly encouraging. The effect of PER on investment incentives is small and could be mimicked by a cut in the statutory tax rate. The latter measure is more salient and would incur smaller administrative and compliance costs than PER.

Evaluation of the benefits of the investment reserve is a more complex task. In certain cases the system works like a neutral cash flow tax. It abolishes the tax wedge caused by standard corporate tax and therefore improves efficiency. However, the results vary depending on several conditions. This might lead to variation in incentives across firms and further to distortions in the allocation of resources. Also, the complexity of the system with possibly non-transparent incentive effects suggests that the system would be costly (high administration and compliance costs) and would not have all the desired effects on investment we found (weak salience).

Moreover, the reserves mainly affect investment financed from retained earnings. If they successfully reduce the cost of capital, they improve the neutrality between investment projects financed by debt and retained earnings, but do not improve the position of external equity. In contrast, a genuine cash flow tax or the allowance for corporate equity (ACE) implements neutral taxation both across different forms of finance and different types of investment projects.

Finally, some provisos are in order. Firstly, the model assumes a fully equity financed firm. Therefore, it cannot address the effects that PER and IVR might have on investment financed by debt. Secondly, the framework assumes that the firm is profitable in all periods. Therefore, it dismisses the possible effects the reserves might have through their potential role as a complement to loss-offset rules. Thirdly, apart the effects on investment incentives this study focuses on, the reserves may also affect investment through a liquidity effect. This effect might be important in the presence of financial constraints.

References

Agell, J. – Englund, P. – Södersten, J. (1995): Svensk skattepolitik i teori och praktik: 1991 års skattereform, Bilaga 1, Statens offentliga utredingar 1995: 104, Stockholm.

Auerbach, A. – Hasset, K. – Södersten, J. (1995): Taxation and corporate investment: The impact of the 1991 Swedish tax reform. NBER Working Paper No. 5189.

Bond, S. – Van Reenen, J. (2007): Microeconometric Models of Investment and Employment. In: Heckman and Leamer (eds.), Handbook of Econometrics, Vol. 6, Chapter 65. Elsevier.

Bond, S. – Xing, J. (2015): Corporate taxation and capital accumulation: Evidence from sectoral panel data for 14 OECD countries, Journal of Public Economics 130, 15–31.

Business Sweden (2015): Corporate Taxes in Sweden – Operating Guide.
www. business-sweden.se

Devereux, M. P. – Griffith, R. (2003): Evaluating tax policy for location decisions, International Tax and Public Finance, 10(2):107–26.

Holm, P. – Huovinen, P. – Koskinen, J. (2016): Yritysverotus, investoinnit ja kasvu. Tutkimusraportti, 31.5.2016. Taloustutkimus Oy.

Kanniainen, V. – Södersten, J. (1995): The importance of reporting conventions for the theory of corporate taxation. Journal of Public Economics 57, 417-430.

King, M.A. – Fullerton, D. (1984): The Taxation of Income From Capital: A Compartivie Study of the U.S., U. K., Sweden and W. Germany. Ed. by M. King & D. Fullerton. Chicago UCP.

Lindhe, T. (2002): Methods of Mitigating Double Taxation. Working Paper 2002:8. Department of Economics, Uppsala University.

Maffini, G. – Xing, J. – Devereux, M.P. (2016): The impact of investment incentives: evidence from UK corporation tax returns. Working Papers 1601, Oxford University Centre for Business Taxation.

Rehn, O. (2016): Sopu kasaan ja investoinnit liikkeelle. Blogi, Suomenmaa, 26.1.2016.

Södersten, J. (1989): The investment funds system reconsidered. Scandinavian Journal of Economics 91, 671-687.

Technology Industry of Finland (2015): Suomen yritysverojärjestelmää on uudistettava – mallia Virosta. Memo, May 2015.

ZEW (2015): Effective tax levels using the Devereux/Griffith methodology – Intermediate report 2015. Center for European Economic Research. Mannheim.

Appendix. Selection of feasible policies

In Sections 4.2 and 5 of the main text, the analysis focuses on a few specific cases. This Appendix aims to illustrate and justify the choice of those cases. We use the term 'policy' for each combination of binding and non-binding constraints for the variables C, G, R and D. We first focus on IVR with a non-binding dividend constraint. Therefore, we omit the ceiling of D. We also dismiss the lower boundary of allocations to the reserve. Finally, we assume constant policies, i.e. the values of the control and state variables stay constant over time.

Non-binding dividend constraint

The mentioned aspects imply that we include the following four constraints: $C \leq C^{max}, G \geq 0$, $G \leq G^{max}$ and $R \geq 0$. The four constraints produce $2^4 = 16$ different policies, each with a different combination of binding and non-binding constraints. Of the potential policies several can be disregarded, however. The first set of such policies is those where $G = 0$ and $G = G^{max}$ at the same time. We drop these policies since $G^{max} > 0$ is assumed. Second, we exclude the combinations where $C > 0$, $G = 0$ and $R = 0$. The reason is that, in a stationary state, $C > 0$ and $G = 0$ should imply $R > 0$. The former measure omits four polices and the latter two policies, implying that we have 10 distinct policies left.

Table A1 illustrates key properties of the 10 policies that passed the first tests. Several of them are still infeasible or uninteresting. Policies P5 - P6 and P9 – P10 are non-optimal in the assumed tax system. To be optimal they would require the fiscal depreciation rate to be clearly higher than assumed in Sec. 2.

Policies P2 and P8 are rejected because they are borderline cases and therefore uninteresting. Policy P2 represents optimal policy only if the ceiling of contributions is set to align with the amount invested by the firm ($C^{max} = G^{max} = I$). This cannot occur regularly in an economy with a number of heterogeneous firms. Policy P8 requires the penalty factor to equal $\frac{1}{B}$, where B is a function of the decay rate b and interest rate ρ. This would be a difficult rule to be followed in tax policy. Besides, P8 has similar incentive properties than P3 (Case 3) and, therefore, we see no good reasons for treating it as an independent policy.

Table A1. Investment reserve, non-binding dividend constraint
(b = binding constraint; n = non-binding constraint; R1 = violates the assumptions concerning parameters; R2 = uninteresting borderline case)

Name	Constraint				Feasible if		Accepted? (Name of the policy, reason for rejecting)
	$C \leq C^{max}$	$G \geq 0$	$G \leq G^{max}$	$R \geq 0$	Penalty factor, z	Other	
P1	b	b	n	n	$1 \leq z < \frac{A}{B}$		Yes (Case 1)
P2	b	n	b	b	..	C^{max}=G^{max}	No (R2)
P3	b	n	b	n	$\frac{A'}{B} < z < \frac{1}{B}$		Yes (Case 3)
P4	b	n	n	b	$z > \frac{A'}{B}$	$A' < 1$	Yes (Case 2)
P5	b	n	n	n	$z = \frac{A'}{B}, z = \frac{1}{B}$	$A' = 1$	No (R1)
P6	n	b	n	n	$z < \frac{A}{B}$, $z = \frac{1}{B}$	$A > 1$	No (R1)
P7	n	n	b	b	$z > \frac{1}{B}$	$A < 1$	yes (Case 4)
P8	n	n	b	n	$z > \frac{A}{B}, z = \frac{1}{B}$		No (R2)
P9	n	n	n	b	$z > \frac{A}{B}$	$A = 1$	No (R1)
P10	n	n	n	n	$z = \frac{A}{B}$	$A = 1$	No (R1)

Policies P1, P3, P4 and P7 turn out to be feasible in the assumed tax system. Under P1, the firm allocates the maximum amount but does not cover investment from the reserve. This policy is optimal if the penalty factor is low $1 \leq z < \frac{A}{B}$. Due to a low penalty rate the firm faces no incentive to use the reserve to cover investment. Policy 1 is case 1 in Sec. 4.2.

Under P3, the firm allocates the maximum amount and covers all investment from the reserve. These aspects and $R > 0$ suggest that $C^{max} > G^{max}$. This implies that a share of the reserve is returned as taxable income with a penalty. The required penalty factor is medium high $\frac{A'}{B} < z < \frac{1}{B}$. It is not so high that the firm would avoid maximizing allocations, nor so low that the firm would avoid using the reserve to cover investment. In Södersten (1989) this policy represents unique optimal policy for the case $0 < G < G^{max}$. In our model it is non-optimal if z is high. These differences derive from differences between the models. Unlike our model, Södersten (1989) does not include the opportunity to enter the reserve as taxable income nor any penalty. This policy is case 3 of Sec. 4.2.

Under P4 the firm maximizes the allocations to the reserve but covers only a share of new investments. The feasibility condition for this policy is z $> \frac{A'}{B}$. Observe that, at this level of z, the firm faces an incentive to use the reserve to cover all investment. So, why is this policy not followed? The apparent explanation is that C^{max} is so low compared to investment that the firm cannot allocate enough funds to the reserve. Therefore $G < G^{max}$ and $R = 0$. This policy is case 2 in Sec. 4.2.

Policy P7 is the case 4 in Sec. 4.2. It is feasible if the penalty factor is high $z > \frac{1}{B}$. Observe that $G = G^{max}$ and $R = 0$, while $C < C^{max}$. It seems clear that this combination requires a high C^{max} compared to investments so that the firm has enough funds in the reserve to cover all investment $G = G^{max} = I$. Due to high penalty factor the firm does allocate the maximum amount C^{max} but rather aligns the amount allocated with investment covered from the reserve $C = G$.

In sum, we found four feasible policies, which represent optimal policy under different conditions. Two aspects of the tax system turned out to be crucial: the size of the penalty factor (z) and the size of the ceiling of allocations (C^{max}). The following Table illustrates how these two criteria define the four cases.

Maximum allocation, C^{max}	**Penalty factor, z**		
	Low, $1 \leq z < \frac{A}{B}$	**Medium, $\frac{A'}{B} \leq z < \frac{1}{B}$**	**High, $z \geq \frac{1}{B}$**
Low, $C^{max} < G^{max}$	Case 1	Case 2	Case 2
High, $C^{max} > G^{max}$	Case1	Case 3	Case 4

Binding dividend constraint

We move on to the case of the binding dividend constraint, $D = D^{max}$. We assume that due to this constraint $0 < C < C^{max}$. There are three binding or non-binding constraints left. Therefore we have $2^3 = 8$ potential policies. Of these, we again omit those where $G = 0$ and $G = G^{max}$ at the same time, and where $G = R = 0$. As a result, we have 5 policies left (Table A2).

Under P1' the firm sets $G = 0$. It lets the reserve to be entered as taxable income, apparently because the penalty factor is particularly low, lower than allowed by our assumptions. We omit this policy.

Under policy P2' the reserve is used to cover investment. Condition $R = 0$ tends to imply that there is a shortage of funds in the reserve. However, all investment is covered, which suggests that there is no scarcity of funds. We also omit this policy.

Table A2. Investment reserve, binding dividend constraint
(b = binding constraint; n = non-binding constraint; R1 = violates the assumptions concerning parameters; R2 = uninteresting borderline case)

Name	**Constraint**			**Comments**	
	$G \geq 0$	$G \leq G^{max}$	$R \geq 0$	**Feasible if**	**Accepted? (name)**
P1'	b	n	n	$z < 1$	No (R1)
P2'	n	b	b	$1 + \frac{\mu_3}{b\tau} < z < \frac{1}{B} + \frac{\mu_3}{b\tau}$	No (R2)
P3'	n	b	n	$1 < z < \frac{1}{B}$	Yes
P4'	n	n	b	$1 < z < \frac{1}{B} + \frac{\mu_3}{b\tau}$	No (R2)
P5'	n	n	n	$z = 1$	No (R2)

Policy P3’ is the base case on which we focus in Sec. 5. All investment is covered from the reserve. Funds in the reserve are sufficiently abundant and do not restrict their use against investment. This suggests the following interpretation. The firm reduces dividends to allow financing of investment. The reduction in dividends releases the dividend constraint and the firm can allocate an amount to the reserve that exactly corresponds to the amount invested. Therefore $C = G = I$.

Under policy P4’ the firm covers only a share of investment from the reserve, probably due to the scarcity of funds in the reserve. This could be caused by some other constraint that becomes binding, for example C^{max}. Due to this ambiguity we omit this case.

Policy P5’ is a boundary case and is related to P3’. As under P4’, the firm only covers a share of investment from the reserve. Now, however, the reason looks clearer. At $z = 1$ the firm is indifferent between using the funds to cover investment and letting them be entered as taxable income. We also omit this policy and, instead, focus on P3’ in Sec. 5.